Copy No.________

Defence Research and Development Canada
Recherche et développement pour la défense Canada

DEFENCE DÉFENSE

The Importance of Metadata in System Development and IKM

Anthony W. Isenor

Defence R&D Canada

Technical Memorandum

DRDC Atlantic TM 2003-011

February 2003

Canada

Copy No:

The Importance of Metadata in System Development and IKM

Anthony W. Isenor

Defence R&D Canada – Atlantic

Technical Memorandum

DRDC Atlantic TM 2003-011

February 2003

Author

Anthony W. Isenor

Defence Scientist

Approved by

J.S. Kennedy

Head, Maritime Information and Combat Systems Section

Approved for release by

Kirk Foster

DRP Chair

Abstract

Metadata is important when considering online data and information management. Metadata allows the data and information to be summarized within the context and language of the content theme. As such, it is important for searches and providing relevant information to the client. A comparison of metadata standards was conducted with emphasis on the standards capacity for geospatial metadata. Five standards were considered in detail: Dublin Core, GILS, GCMD, FGDC and ISO 19115. Each standard was considered from the standpoint of the required minimum information set and the geospatial information set. The usefulness of the various standards to geospatial data and information is considered within the context of ocean environmental data. Results indicate the FGDC standard is a complete and succinct metadata standard, with sufficient scope to be applicable to a wide variety of datasets.

Résumé

Les métadonnées ont une grande importance dans la gestion en ligne des données et des informations. Elles permettent de résumer les données et les informations dans le contexte même en utilisant le langage du contenu. Les métadonnées sont utiles pour les recherches et pour fournir des renseignements pertinents au client. L'analyse comparative des normes sur les métadonnées a mis l'accent sur la capacité des normes à traiter les métadonnées géospatiales. Cinq normes ont été analysées en détail : Dublin Core, SLIG, GCMD, FGDC et ISO 19115. Chaque norme est évaluée en tenant compte des informations minimales requises et des informations géospatiales. Le caractère utile des diverses normes pour les données et les informations géospatiales est abordé dans le contexte des données océaniques environnementales. D'après les résultats de l'étude, la norme FGDC est une norme de métadonnées à la fois complète et succincte dont la portée est suffisante pour être applicable à un large éventail d'ensembles de données.

This page intentionally left blank.

Executive summary

Background

Geospatial data is any data or information with spatial and/or temporal components. Such data is common in our everyday lives. As an example, geospatial data is present in such things as weather forecasts. Daily maps of weather conditions are provided in the local newspaper and allow readers to locate areas important for their needs. This georeferencing can be applied in a slightly more advanced manner, across very large regions using Internet access to satellite images of global weather conditions.

Geospatial data has obvious use in a military context. Geospatial data may represent environmental conditions, deployment distribution or object tracking. Monitoring networks also typically possess a geospatial component, as the monitoring is typically at one or more locations over an extended period of time.

The ubiquitous nature of geospatial data combined with the large data volume makes it difficult to locate datasets useful for a particular task. With an increased emphasis on network centric sharing of data and information, the process of identifying and using datasets will become more important to the client (human or process).

Metadata plays a key role in this identification process. Metadata is often described as 'data about data': it is a set of descriptive characteristics that qualitatively or quantitatively describe a dataset. If properly structured, these descriptors provide a means to discover, transport and use a data or information set.

Principal Results

There are numerous geospatial metadata standards. This reports examines five leading standards: the Dublin Core, the Global Information Locator Service, the Global Change Master Directory, the Federal Geographic Data Committee standard and the International Organization for Standardization geographic information metadata standard 19115.

All are examined from the standpoint of applicability and usability for systems using data or information. The relevance of the standard for the expected use and the readability of the documentation for general understanding are considered. The explicit functional requirements of each standard are not described as it is outside the scope of this report. However, the investigation does highlight the minimum information set required for each standard. The geospatial information set from each standard is also considered.

The investigation identifies the Federal Geographic Data Committee standard for geospatial data and information as the most useful one to defence and scientific

research. This standard is compact, clearly written and meets the needs of the research community. The other standards are difficult to follow or do not match the level of detail required for scientific research.

Significance of Results

Metadata plays a crucial role in any network sharing of data and information. This is partially due to excessive data volumes, which limit the sharing of unprocessed datasets. When condensed information is shared, the metadata is used to describe the shared and/or original dataset. The metadata provides the user with the information for understanding the content of the dataset. Understanding the international standards used to share geospatial metadata provides valuable basic knowledge for understanding, planning, constructing and operating network-sharing systems, such as those being considered for future sensor systems, and command and control systems for multi-platform naval operations.

Future Plans

An important component of the infrastructure used in a data sharing system is the underlying database. A system may in fact be composed of multiple databases or databases with differing functionality, yet in very fundamental terms the database remains the storage or translation layer among the sharing platforms. Hence, the geospatial metadata within the system will reside in a database of some form.

Database structures designed for net-centric data sharing are now under development by various international partners. Prospective structures are being examined and tested for functionality with consideration to Canadian naval requirements.

Isenor, Anthony W. 2003. The Importance of Metadata in System Development and IKM, DRDC Atlantic TM-2003-011, Defence R&D Canada – Atlantic.

Sommaire

Contexte

Les données géospatiales sont des données ou informations à composantes spatiales et/ou temporelles dont nous nous servons tous les jours. À titre d'exemple, les prévisions météorologiques reposent sur des données géospatiales. Les cartes sur les conditions météorologiques que le journal local publie tous les jours permettent aux lecteurs de localiser les régions qui les intéressent. On peut utiliser ce géoréférencement pour des applications plus poussées sur des régions encore plus vastes en visualisant par Internet des images satellites des conditions météorologiques mondiales.

Les données géospatiales sont évidemment très utiles dans le contexte militaire. Les données géospatiales peuvent servir à représenter des conditions environnementales, des zones de déploiement ou la poursuite d'objets. Les réseaux de surveillance possèdent également une composante géospatiale étant donné que la surveillance est réalisée en général à un ou plusieurs endroits pendant une période de temps prolongée.

L'omniprésence des données géospatiales, conjuguée à leur grande quantité, rend difficile la localisation d'ensembles de données pour une tâche particulière. Étant donné l'accroissement du partage réseaucentrique des données et des informations, il deviendra de plus en plus important pour le client (humain ou processus) d'identifier et d'utiliser des ensembles de données.

Les métadonnées ont un rôle primordial à jouer dans le processus d'identification. Souvent décrite comme des « données sur des données », les métadonnées constituent un ensemble de caractéristiques qui décrivent de façon qualitative ou quantitative un ensemble de données. Bien structurées, ces descripteurs permettent de découvrir, de transférer et d'utiliser un ensemble de données ou d'informations.

Principaux résultats

Il existe de nombreuses normes sur les métadonnées géospatiales. Les cinq normes les plus connues feront l'objet de notre analyse : le Dublin Core, le Service de localisation de l'information du gouvernement, le répertoire Global Change Master Directory, la norme du Federal Geographic Data Committee et la norme 19115 (Information géographique – métadonnées) de l'Organisation internationale de normalisation.

L'évaluation est réalisée sous l'angle de l'applicabilité et de l'utilité de la norme pour les systèmes de données ou d'informations. Nous analysons la pertinence de la norme sur le plan de l'utilisation prévue et de la lisibilité générale de la documentation. Les exigences fonctionnelles explicites de chaque norme ne sont pas décrites dans le présent rapport. Cependant, les informations minimales exigées pour chaque norme y

sont énumérées. Nous évaluons également les informations géospatiales utilisées dans chaque norme.

Pour la recherche militaire et scientifique, la norme du Federal Geographic Data Committee sur les données et les informations géospatiales s'avère la plus utile. Cette norme est concise et rédigée avec clarté et elle répond aux besoins des chercheurs. Les autres normes sont difficiles à suivre ou ne permettent pas des recherches aussi détaillées que l'exigent les scientifiques.

Signification des résultats

Les métadonnées jouent un rôle crucial dans tout partage de données et d'informations en réseau du fait qu'en partie, les grands volumes de données limitent le partage des ensembles de données non traités. Lors du partage d'informations condensées, les métadonnées servent à décrire les ensembles de données partagées et/ou originales. Les métadonnées renseignent l'utilisateur sur le contenu des ensembles de données. L'avantage de connaître les normes internationales utilisées pour partager les métadonnées géospatiales est de faciliter la compréhension, la planification, la construction et l'exploitation des systèmes de partage de réseau, comme ceux qui sont présentement à l'étude pour les capteurs et les systèmes de commande et de contrôle qui sont utilisés pour les opérations navales multi-plateforme.

Plans pour l'avenir

La base de données sous-jacente est un élément clé de l'infrastructure d'un système de partage de données. Un système peut, en fait, être composé de plusieurs bases de données ou de bases de données ayant des fonctions différentes. Cependant, il faut garder à l'esprit que la base de données demeure la couche de stockage ou de traduction entre les plates-formes de partage. Les métadonnées géospatiales d'un système doivent donc être stockées dans une base de données.

Divers partenaires internationaux sont en train de développer des systèmes de partage de données réseaucentriques. Des structures possibles font actuellement l'objet d'un examen et leur fonctionnalité est testée en tenant compte des besoins du Canada dans le domaine naval.

Isenor, Anthony W. 2003. The Importance of Metadata in System Development and IKM, DRDC Atlantic TM-2003-011, Defence R&D Canada – Atlantic.

Table of contents

List of figures

This page intentionally left blank.

1. Introduction

As recently as a decade ago, the primary problem to data sharing was access. Data delivery was complicated and not user friendly. The problem has changed with the introduction of the Internet. Access is no longer the problem. Using the Internet, one can download data from any number of sources. Now the problem is dealing with the volume of data obtained and determining the meaning and applicability of the acquired data. Of course, understanding the acquired data is not a problem associated only with the Internet. The data acquisition could have been from the intranet or the person in the next cubicle.

There are currently many activities within Defence R&D Canada – Atlantic (DRDC Atlantic) related to the use and flow of data. Software applications, such as the Sonar Test Bed (STB), rely heavily on the sharing of data and information between components of the system. Typically, the data sharing is in a very controlled structure that helps ensure cross-component understanding of the dataset.

In large, distributed systems, one may encounter conflicts with data understanding between applications or clients. In an abstract sense, the clients of the system need not be limited to software. They could include humans that are in some way using data or information that has been acquired within the context of the bigger system. In such systems, the transfer of information between existing systems is critical to the sharing of information and resources. In this model of information sharing, at some level the structure of the shared data will become an issue. At the simplest level, the sharing can take place between individual software components in a single application. At a more complicated level, the sharing may be between systems developed independently at many remote research laboratories.

As the level of the sharing becomes more complicated, the necessity for standardization of the shared information increases. At the simple level, only the requirements of two software components need be considered when constructing the data and information transfer structure. At the complicated level, the requirements of many components need to be considered. At this level, standard structures are applicable.

Metadata is critical to the success of the management process for understanding, organizing and managing the data or information. Metadata, which is defined more clearly in the following section, is the descriptive information that accompanies the data. Ideally, metadata provides a summary of content that enables the user to assess the applicability of the content for the intended use. In one model, the client is responsible for pulling the content from the provider based on the metadata summary. Metadata is also relevant in a push model, where the user could provide details of the required information in the form of metadata and the system provides content that meets the requirements.

This document considers five metadata standards in detail: the Dublin Core, International Organization for Standardization (ISO) 19115, the Global Information Locator Service (GILS), the Global Change Master Directory (GCMD), and the Federal Geographic Data Committee (FGDC) standard. The document first outlines the importance of metadata in the management process and reviews some current usage of the standards in external organizations or groups addressing similar issues. The relevance of metadata to activities within DRDC Atlantic is also described. Finally, the standards are examined by considering the minimum information set as defined by each standard and the geospatial characteristics of the standards.

Throughout the document there is considerable subject-specific terminology. These terms will be outlined here to prepare the audience for the sections that follow.

Within this report, the reader may consider *data* as discrete units of numbers or characters that have been measured and digitized. *Information* is a result of analysis of data, to obtain an understanding of some process or characteristic of the system to which the data apply. This report considers data and information together as a *collection*. Also, data may be stored electronically within a software system, or *database*.

The process of designing a database is termed *data modelling*. Data modelling is the equivalent of creating blueprints for the database. In turn, a database is a collection of data in a structured form, with internal *integrity constraints* built into the structure. These integrity constraints contain inter-relationships within the data structure, thereby placing limits on certain database content using other data already contained in the database. A *data store* is a special type of database. A data store is an operational database that contains only current data and is oriented toward a very specific subject.

Also within this report are users, clients, providers and receivers. A *user* is a human attempting to use the collection. A *client* includes user, but is extended to also include a request from software. A *provider* of data is any client that shares or supplies data to a request. The client obtaining the data is considered the *receiver*.

An *organization* is any group of users or clients dealing within mutual business topics. An *application* is a software system that meets a specific need of an organization, user or client.

There are also many terms within this paper related to electronic metadata storage. In this context, an electronic unit of data that can be treated, processed or manipulated as a unit will be termed a *dataset*. Within the dataset, an individual container for metadata will be described as a *tag*. A *namespace* will be used to name a group of tags related by a single topic. The syntax for the naming of a tag may take many forms. For example, the naming could be lower camel case or upper camel case. *Lower camel case* is a capitalization pattern where the first letter of the first word is not capital, but all remaining word first letters are capital, with no spaces between words (e.g. codeName). *Upper camel case* has capitalization of all word first letters, with no spaces (e.g. CodeName).

2. Importance of Metadata

Research within many organizations is supported by data. Data are collected to test a hypothesis, or to confirm an existing theorem. Typically, within a research-oriented organization, the data are collected and processed to meet a particular need. To increase the cooperative efforts of the international community there is now a recognized need for community wide sharing of data. This promotes data use and improves the cost-benefit ratio. Increased use in turn improves data quality and thereby enhances the longevity of data usefulness within the community. This ability to use data for a particular need is related to the accompanying metadata.

2.1 Defining Metadata

Defining metadata is a difficult task. This is because metadata is in itself defined by one's perspective. An ever-changing perspective provides the difficulty when searching for an exact definition.

The most commonly used definition of metadata is simply data about data. Although somewhat abstract, this essentially means that *metadata* are descriptive characteristics that qualitatively or quantitatively describe or support a dataset. These descriptions provide the necessary context for the dataset and by including such descriptions the data provider helps ensure the use of the data in applications unrelated to the initial reason for data collection.

To understand this definition, we first start with the term dataset. Previously, dataset was defined as a unit of data that can be treated, processed or manipulated as a unit. The unit aspect of a dataset means it may be treated as a single entity or object. As with traditional real-world objects, or software objects, datasets may be contained within other datasets, resulting in a hierarchy of datasets. Metadata exists at all levels of the hierarchy and metadata at one particular level may be considered data at another level of the hierarchy.

This dataset hierarchy is illustrated by considering an example involving ocean temperature profiles collected by expendable bathythermographs (XBT). Consider a series of XBT drops that result in a straight-line section of temperature profiles in a region of the ocean. Each profile has an associated position in space and time. At the level where a profile is considered a dataset, the temperature values may be considered the data. At this level, the supporting information or metadata includes the position and time of the profile. Now consider the view at a higher level, where dataset is considered the entire collection of profiles. At this level, position information for the profiles may be considered data. For example, in a plot showing XBT drop locations the data that composed the plot are the positions of the profiles.

This transition from data to metadata causes considerable confusion. The perspective must be considered when attempting to reduce this confusion.

2.2 The Functions of Metadata

Metadata provides the user with the ability to understand and use the data. If properly structured, the metadata will describe and clarify the meaning and relevance of the ensuing data stream. Using digital communication, it is suggested that metadata provides support for three basic functions: discovery, transfer and use. Each are elaborated below.

Discovery – Metadata should be structured to support advanced search capabilities. This may be particularly important when considering knowledge management. Knowledge management places emphasis on the context for knowledge. Context is critical to the proper interpretation of the content and establishing new uses for the data in a different context. Metadata will play an important role in the process of locating the required collection in the existing plethora of information. As well, metadata will provide the historical significance for a collection, describing it in sufficient detail to enable proper and legitimate use of the collection. In broader terms, in the next generation of the World Wide Web, termed the semantic web, context identification by way of automatic content scanning will play a key role [1].

Transfer – To be of use, the collection must be transferred from provider to receiver. Such transfers may involve applications or organizations. As well, transfers may include organisations outside the original topic area for which the data were collected. The transfer must consider factors such as security of the collection and possible proprietary use of the collection. The metadata must support this transfer by providing transfer-related details such as access information, distribution rights, and recording formats.

Use – Ultimately, the collection is to be used for some purpose. The metadata supports the use of the collection by providing an understanding of the content. This is important for the processing and manipulation of the content by the receiver. Good metadata provides sufficient details for the receiver to use the data with a degree of comfort that the supplied data meet the receiver's needs.

The discovery, transfer and use of a dataset may take many forms. An example of such a sequence could involve many platforms collecting diverse, but complimentary datasets. These datasets could be accessible through some communication system. Clients at the individual platforms could query and thus determine the data resources within the communication system that meet their local needs. A request for a specific dataset would then be made and the dataset transferred to the client. The client would then use the dataset by fusing the data with locally collected data, thereby enhancing the collective efforts of the platforms.

3. Review of Metadata Practices

It is important to understand the use of metadata standards within organizations. The following briefly describes metadata practices within three organizations. We consider the Canadian Government, the US Defence Information Agency and the World Meteorological Organization.

3.1 Canadian Government

The Canadian government has examined metadata requirements within the context of information management, with particular emphasis on the Government On-Line (GOL) initiative [2]. GOL is a major Canadian effort to provide government services and information on-line to Canadians by 2004 [3].

In response to this initiative, the Government On-Line Ad Hoc Interdepartmental Metadata Working Group [4] was formed in 2001 to address metadata issues related to GOL. The Working Group had representation from 16 government departments or agencies. There was no representation from the Department of National Defence (DND).

The Working Group examined two existing metadata descriptions, the GILS and the Dublin Core. The Working Group considered these two descriptors against 17 criteria including such points as adoption by other governments, extensibility, simplicity for adding descriptors, etc. The Working Group did not specifically consider geospatial data, but rather the issue of government services and information. The Working Group concluded that the Dublin Core best met the defined requirements.

3.2 Defense Information Systems Agency

The Defense Information Systems Agency (DISA) has an architecture and software infrastructure that defines an application-independent environment, known as the Common Operating Environment (COE). An important aspect of this common environment is the development of data-related infrastructure that promotes interoperability. In this regard, the DISA Shared Data Engineering group (SHADE) has produced a set of 13 data categories, or namespaces, each containing a gallery or set of tags. The tags describe common battlefield objects such as organization, materiel, personnel, etc. within the namespace.

Currently, the 13 defined namespaces are:

Acquisition logistics	Geospatial and imagery
Aerospace operations	Group operations
The COE	Logistics
Combat systems	Meteorological and oceanographic
Controller exports	Personnel, and
Finance and accounting	Tracks and reports
General military intelligence	

DISA also provides a means to suggest extensions to the registry via an online input system called the manifest definitions.

There are considerable metadata requirements contained within the 13 namespaces noted above. However, there is very little information relating these metadata requirements to any metadata standard. Indeed, this system is more self-defining and does not appear to take advantage of existing standards.

3.3 WMO Commission for Basic Systems

The World Meteorological Organization (WMO) is a specialized agency of the United Nations. Formed in 1951, it consists of 179 member states (as of 1996). The WMO is tasked with facilitating international cooperation on the establishment of meteorological observation networks and data exchange. As well, the WMO deals with the standardization of the exchange mechanism. As such, the WMO is often associated with leading the interchange of data for the support of established real-time or near real-time systems. It is within the context of established real-time expertise that we consider the WMO.

The WMO works within a development team paradigm and has established numerous teams including the Commission for Basic Systems (CBS). Within the Commission is an Expert Team on Integrated Data Management.

The CBS is an important contributor to the flow of global environmental data. The CBS is responsible for the Global Telecommunications System (GTS), which forms the backbone of the real-time distribution of weather related data and metadata. This includes ocean data important for weather forecasting models. The GTS data stream is also received by military agencies. For example, the Meteorology and Oceanography

Centre (METOC) office of DND obtains data distributed over the GTS for input to DND ocean summaries.

The Expert Team working for the CBS recently began a metadata standards evaluation as part of improvements to the communication system [5]. This activity has related WMO activities, such as the WMO work (Gorman [6]) that is considering possible meteorological standards for eXtensible Markup Language (XML) usage. CBS is concerned with all aspects of real-time delivery of metadata and data to the global community.

The Expert Team considered five metadata standards, the Dublin Core, ISO 19115, GCMD, FGDC and the Australia/New Zealand Spatial Information Council standard. Based on the preliminary assessment, two standards were considered in further detail – the Dublin Core and the ISO 19115. The Team concluded that both the Dublin Core and the ISO standard could be used within WMO applications. However, the Team did want further investigation of the ISO standard to ensure the standard could be extended to accommodate WMO requirements. This investigation is ongoing.

4. Metadata Related Activities at DRDC

Having established the importance of metadata, we now explore its relevance to some sample activities at DRDC. This section briefly outlines two key activities within DRDC where metadata plays an important role.

4.1 IKM and Metadata

Knowledge management is becoming an important component of activities within DRDC. Within DRDCs Corporate Management Business Line 4, information and knowledge management (Change Objective 29) is described as a means to increase the abilities of "*decision makers to absorb, understand and integrate science and technology knowledge into planning and operations*" [7].

Here, "corporate" is distinguished from "business". In the traditional language of business, "corporate" places the focus on the employee while "business" places the focus on the customer. Corporate indicates the management of knowledge to serve the needs of the organizations employees. This is the standard definition of knowledge management [8], where emphasis is placed on providing employees with the knowledge required to do their jobs more effectively. This definition does not include providing customers with the information they need to do their task more effectively.

Metadata plays an important role within any technological process that makes information available together with its contextual framework. Metadata is information. Within the IKM framework, the metadata describes the data or information, placing either within a context that allows the discovery of content.

Technology plays a role in IKM, in particular providing a mechanism to locate data and information sources. Metadata describing the information sources is critical to a successful discovery. Consequently, the model used to contain the metadata must provide a framework for search-relevant metadata.

4.2 Sonar Test Bed and Metadata

The Sonar Test Bed (STB) is a system under development at DRDC Atlantic that provides a data store architecture for sonar related applications. The data store represents a storage mechanism that provides data to a suite of applications. The data store itself conducts very little internal consistency checking on the data.

A complete data model for the STB data store is currently being developed. Initial investigations indicate that metadata is present in the form of space-time descriptions, data and group names, data update rates, etc.

Metadata will also be important when combining datasets. This may be a sensible requirement of the STB as the system evolves towards an environment capable of data fusion functions. Fusion tasks will require knowledge of detailed data and information characteristics that can be supplied in metadata structures.

Metadata is also relevant within the configuration files of the STB. These configuration files define the scenario being examined with the STB and orchestrate the operation of the STB.

Enhancing the metadata within the STB configuration files may be necessary as the STB gains acceptance within DRDC Atlantic. One could envisage an assortment of configuration files that together form the basis of a testing and education system. The test component could be used for assessing novel algorithms against standard ones. The education component could include developed tutorials for employees to gain an understanding of the STB in general, or an understanding of the processing and standard outputs common to acoustic tracking. In these cases, the metadata would be used to manage the collection of scenarios for the components.

4.3 Metadata Structures

As described above, metadata has at least two important links to activities within DRDC Atlantic: the STB and IKM. The accessibility of the metadata is one contributor to the longevity of data use. As such, the structures that house the metadata are very important as these structures help define the permitted content.

The metadata structure may be discussed and defined without actually describing the method of implementation. Such methods will depend on details of the solution and may involve classes (object orient approach), fields (database approach), etc. The implementation of the metadata structure is beyond the scope of the current report. Here, the metadata structures will be considered as abstract generalizations that typically travel in groups.

The idea of metadata groups is common in the field of data modelling. In terms of ocean environmental data, a Canadian group is working towards a common set of data groups, called Keeley Bricks, to house the data and metadata associated with oceanographic research [9]. These bricks will ultimately include metadata storage locations either defined within the scope of the Canadian project or from pre-existing standards drafted by other organizations.

5. Metadata Initiatives

The following provides a broad overview of the five standards being considered. The size and scope of these standards necessitate such an overview to provide the reader with a basic understanding of subject areas applicable to the standards. Details of the standards such as minimum information sets and specific usage in geospatial applications are considered in the next major section. For a more complete list of efforts related to metadata standards, see Hass [10].

5.1 Dublin Core

The Dublin Core Metadata Initiative [11] began in 1995 with an initial meeting in Dublin, Ohio. In September 2001 the US National Information Standards Organisation [12] adopted the Dublin Core as a standard for metadata exchange.

The Dublin Core is used primarily in document management. Common software packages use the Core to structure metadata for documents. For example, Core tags are used in Adobe .pdf files as metadata tags.

The Dublin Core consists of 15 descriptors and definitions that encapsulate metadata typically for library document management. Some of these 15 descriptors have qualifiers that help refine the structure. The simplicity of the Core provides both its strength and weakness. With only 15 descriptors, the Core is straightforward to understand and apply but it is limited within the description topics.

The 15 descriptors that make up the Dublin Core are as follows:

Title	Format
Creator	Identifier
Subject	Source
Description	Language
Publisher	Relation
Contributor	Coverage
Date	Rights
Type	

The Core is not suited for geospatial data because it lacks geospatial characteristics. The geospatial elements may be added as qualifiers but would not form part of the basic Core. Suggestions may be made to the group overseeing the Dublin Core Metadata Initiative concerning additional tags that might serve as qualifiers.

5.2 ISO 19115

The International Organization for Standardization (ISO) is a body that establishes international standards. Many ISO standards are encountered in our daily lives. For example, the country code on the end of an email address is an established ISO standard [13] as well as the form of a reference section within a report [14].

ISO activities are conducted through Technical Committees (TC). TC 211 is the Geographic Information/Geomatics Committee responsible for metadata requirements of geospatial data. One effort of TC 211 has been ISO 19115. This metadata standard is now in the voting stage of becoming an official standard.

The current draft ISO 19115-3 [15] illustrates the data model for the standard. The document outlines the structure in the Unified Modelling Language (UML) and includes a detailed description of the entities and attributes. The data model is extensive, covering such topics as:

dataset access constraints,

dataset maintenance frequency,

raster, vector spatial representations,

spatial-temporal reference system,

distribution details (fees, availability, media, ...),

spatial extent of the dataset, and

citation, contact and responsible party information.

Draft 19115-3 is comprehensive and complicated. The 19115-3 is comprised of over 300 metadata elements. It makes extensive reference to other existing standards. Although effective, this does tend to make the documentation difficult to follow.

5.3 GILS

The Global Information Locator Service (GILS; note that the "G" initially represented Government) is an Internet client-server protocol specification that specifies how to express a search and return results. The specification lists metadata elements that are similar to Dublin Core. However, GILS includes a geospatial component.

The GILS standard defines required use and available use attributes. Here, required use attributes are defined as those attributes that must contain information to be in compliance with the GILS standard. Available use attributes are all non-required use attributes.

The required use attributes are as follows:

Title	Any
Local Number	Record Source
Local Subject Index	Anywhere
Author-name corporate	Distributor Name
Date/Time Last Modified	Index Terms

There are about 79 available use attributes. These attributes include structures for geospatial data, contact information, distribution information, security and access constraints.

The GILS also supports objects from other structures. For example, the GILS supports tagSet-M and tagSet-G, as defined in the ANSI/NISO Z39.50-1995 [16] standard. These tagsets include tags associated with database record metadata (tagSet-M) and generic document tags (tagSet-G).

5.4 GCMD - DIF

Global Change Master Directory (GCMD) is an initiative under the National Aeronautics and Space Administration (NASA) to define the metadata related to earth science data, in particular, those data in support of the NASA Earth Observing System Data and Information System (EOSDIS). The GCMD has defined the Directory Interchange Format (DIF) as the structure used to house the metadata.

The DIF structure is composed of about 80 elements. There are lists of valids for some elements. *Valids* are predefined lists of acceptable content for an element. Valids can cover broad topics including ocean related entries such as “acoustic frequency” or “ocean tracers” to accommodate datasets with a broad extent.

The GCMD is currently available for entry using online forms that the user completes and submits to a central database. The same database is also available for searching. The DIF is not user extendable.

GCMD is also being used within the Intergovernmental Oceanographic Commission’s Marine Environmental Data Information (MEDI) referral catalogue [17]. MEDI provides a subject-specific version of a GCMD implementation. MEDI is also available online for user searching or entry. MEDI focuses on earth science datasets relevant to global change research.

5.5 FGDC - CSDGM

The US Federal Geographic Data Committee (FGDC) has outlined the Content Standard for Digital Geospatial Metadata (CSDGM) [18, 19]. In this regard, the FGDC standard differs from the Dublin Core’s emphasis on document management. In 1994, the FGDC standard was part of the Executive Order signed by President Clinton as part of the US National Spatial Data Infrastructure. The FGDC standard was developed with representation from 14 US Departments or Agencies, including the US Department of Defense and NASA. FGDC is a geospatial-specific extension of GILS.

There are about 195 elements within the FGDC standard. The standard documentation and workbook clearly outline the data modelling notation and the actual data model. There are valids within this system. However, the valids are composed of short defined lists. For more extensive lists, the user has the ability to declare list names from a thesaurus. After declaring the thesaurus, the user has available elements that are used to include words from the thesaurus. Such keyword lists are used for place names, themes, and temporal periods.

The FGDC standard is composed of seven metadata components:

- Identification
- Data Quality
- Spatial Data Organization
- Spatial Reference
- Entity and Attribute
- Distribution
- Metadata Reference

The standard defines short names for all elements. Short names are all lowercase, with an eight-character maximum. The documentation is clear and complete (meaning it is self-contained).

The FGDC standard has been selected as the initial standard for the US Integrated Ocean Observing System (IOOS) [20]. This is a US contribution to the Global Ocean Observing System (GOOS). IOOS is now conducting a review to fully assess the standards ability within the system requirements.

6. Minimum Requirements and Geospatial Characteristics

The previous section provided an overview of each standard in isolation from the others. We now consider a comparison of the standards in two specific areas – the minimum information set required by each standard and the geospatial metadata capabilities of each standard.

6.1 Minimum Sets

The objectives of an organization must be fully understood before recommending or selecting any type of standard. Obviously, shared requirements between organizations and sometimes within an organization will vary depending on the application, each possibly calling for different standards.

The selection of a standard is a balancing act. Some standards may overly complicate the problem by introducing requirements that inhibit the process. On the other hand, overly terse standards may not meet the needs of the client.

Section four outlined the various standards being considered, and the general topic areas of those standards. Here, we consider some of the standard details and in particular use the minimum set of mandatory information as a benchmark for comparing the standards.

The *minimum set* is that group of tags that must be present within the metadata structure, as defined by the mandatory tags in the standards data model. The Dublin Core minimum set has no mandatory fields, though specialized implementations of the Core have defined a minimum set. An example is the Colorado Digitization Project [21] (CDP), which defined a set of seven mandatory Dublin Core elements for their particular implementation. The CDP minimum set is shown in Figure 1.

- Title
- Creator
- Subject
- Description
- Identifier
- Date: Digital
- Format: Creation
- Format: Use

Figure 1. Minimum set required for the Colorado Digitization Projects implementation of the Dublin Core.

The GILS likewise does not define a minimum set, although specialized implementations of the GILS often define a minimum set. As an example, consider the Canadian GILS Guidelines [22] as provided by the National Library of Canada (NLC), a lead party in the establishment of GILS use within the Canadian Federal Government. Figure 2 illustrates the minimum set of information suggested by the NLC as based on the GILS. The Figure shows the bias towards library information where only the basic title, originator, language and modification date are required.

- Title
- Originator
- Language of Resource
- Record Source
- Language of Record
- Date of Last Modification

Figure 2. Minimum set required for the GILS standard, as defined in the Canadian implementation by the National Library of Canada.

Neither the Dublin Core nor the GILS specifies a minimum set owing to their broad target application. The domain of the data being specified may nevertheless dictate a minimum set.

The GCMD does define a minimum set of descriptors for a dataset, as shown in Figure 3. The set identifies the entry record by title and ID, and the dataset by summary, parameters and data centre. This data centre view highlights the GCMDs perspective of a national or centralized archival system that supports the entry of the metadata records. This type of view is evolving toward a more decentralized, trans-national data access system.

The FGDC and ISO minimum sets are illustrated in Figures 4 and 5, respectively. The FGDC minimum set shows emphasis on the ownership, access and description of the collection. In contrast, the ISO minimum set recognizes ownership and general topic. The language identifier illustrates the international audience of the ISO standard.

The minimum set of the ISO standard should not be confused with the essential set as defined by ISO. The minimum set is that set defined by the mandatory elements in the standards data model. The essential set as defined by ISO, defines what the TC considers the minimum group of descriptors for describing a dataset.

The minimum set of the FGDC exceeds those of the other standards, due mainly to its geospatial nature. The inclusion of temporal-spatial bounds on the dataset is an example of this. There is also the concept of data evolution, as indicated by the update frequency. The increased mandatory set does place added burden on the production of a minimum FGDC information set.

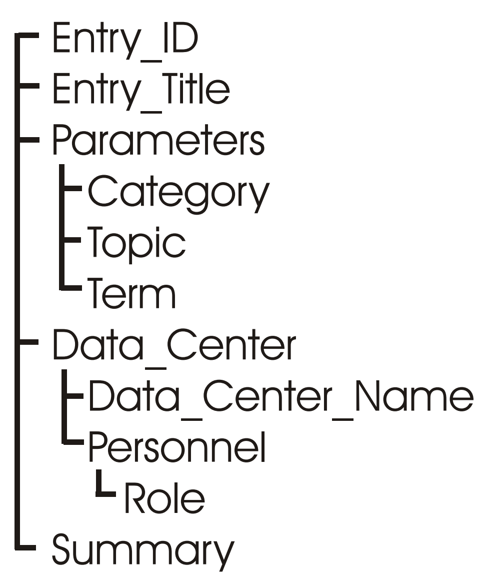

Figure 3. Minimum set required for the GCMD standard.

- Identification_Information
  - Citation
    - Citation_Information
      - Originator
      - Publication_Date
      - Title
  - Description
    - Abstract
    - Purpose
  - Time_Period_Of_Content
    - Time_Perod_Information
      - Single, Multiple or Range of Dates
    - CurrentnessReference
  - Status
    - Progress
    - Maintenance_And_Update_Frequency
  - Spatial_Domain
    - Bounding_Coordinates
      - West_Bounding_Coordinate
      - East_Bounding_Coordinate
      - North_Bounding_Coordinate
      - South_Bounding_Coordinate
  - Keywords
    - Theme
      - Theme_Keyword_Thesaurus
      - Theme_Keyword
  - Access_Contraints
  - Use_Contraints
- Metadata_Reference_Information
  - Metadata_Date
  - Metadata_Contact
    - Contact_Information
      - Contact Person or Organization
      - Contact_Address
        - Address_Type
        - City
        - State
        - Postal_Code
      - Contact_Voice_Telephone
  - Metadata_Standard_Name
  - Metadata_Standard_Version

Figure 4. Minimum set required for the FGDC standard.

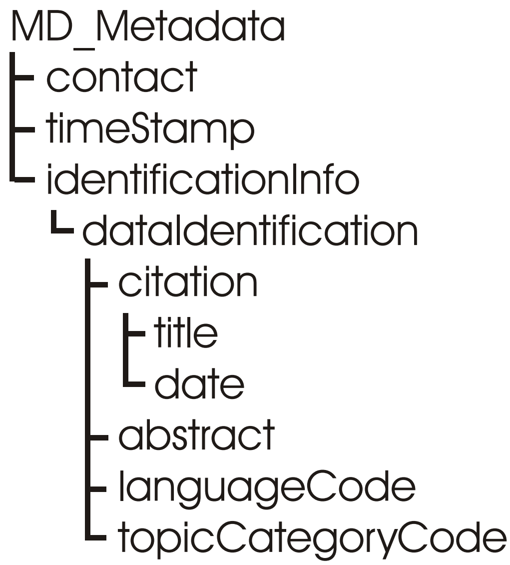

Figure 5. Minimum set required for the ISO 19115 standard.

6.2 Geospatial Metadata

Here we are interested in standards related specifically to geospatial datasets and the associated metadata. Consider Figure 6, which illustrates the metadata structures pertaining to the spatial coverage of a dataset. The actual tag names used within the metadata structure are shown. The Dublin Core, being based on library collections, does not support geospatial data. The GCMD and GILS support geospatial data within a single structure. As well, GILS does not have the capacity to support vertical positioning. The FGDC and ISO standards support both horizontal and vertical definitions. FGDC supports altitude definitions as distinct from vertical depth definitions.

The packaging of vertical and horizontal groups is unique to the ISO and FGDC standards. The packaging allows the mandatory sub-fields to travel and be processed as a group. This represents an integrity constraint on the data space when dealing with that type of data. The GCMD, in contrast, allows all spatial coverage information to be optional. This form is more prone to incomplete coverage information.

The mandatory requirement of the FGDC spdom element (see Figure 6; spdom represents “spatial domain”) is also unique to that standard. This mandatory status indicates the emphasis on spatial content.

Dublin Core

None Available

FGDC

- spdom (M,NR)
  - bounding (M,NR)
    - westbc (M.NR)
    - eastbc (M.NR)
    - northbc (M.NR)
    - southbc (M.NR)
- vertdef (MA,NR)
  - depthsys (MA,NR)
    - depthdn (M,NR)
    - depthres (M,R)
    - depthdu (M,NR)
    - depthem (M,NR)

GCMD

- Spatial_Coverage (O,R)
  - Southernmost_Latitude (O,NR)
  - Northernmost_Latitude (O,NR)
  - Westernmost_Longitude (O,NR)
  - Easternmost_Longitude (O,NR)
  - Maximum_Altitude (O,NR)
  - Minimum_Altitude (O,NR)
  - Minimum_Depth (O,NR)
  - Maximum_Depth (O,NR)

ISO 19115

- GeoExt (O,R)
  - GeoBndBox (C,R)
    - westBL (M,NR)
    - eastBL (M,NR)
    - southBL (M,NR)
    - northBL (M,NR)
- VertExt (O,NR)
  - minVal (M,NR)
  - maxVal (M,NR)
  - uOfMeas (M,NR)
  - vetDat (M,NR)

GILS

- SpatialDomain (O,NR)
  - BoundingCoordinates (O,NR)
    - WestBoundingCoordinate (M,NR)
    - EastBoundingCoordinate (M,NR)
    - NorthBoundingCoordinate (M,NR)
    - SouthBoundingCoordinate (M,NR)

Legend
O - optional
M - Mandatory
MA - Mandatory if applicable
NR - Not Repeating
R - Repeating
C - Conditional

Figure 6. Illustration of the structure used to contain spatial information in the five standards considered within this document. This figure uses the actual tag names associated with the structures. For example, in comparison with Figure 4, the FGDC standard identifies "spatial_domain" using the tag name "spdom". The codes within the parentheses () are not part of the tag name.

Syntax issues within the standards should also be noted. Syntax is particularly important for developers writing software applications. Clear and simple rules for naming metadata tags reduce coding errors. Things to note within the standards include the use of upper camel case in GILS and the underscore separator in GCMD. The ISO standard uses lower camel case with abbreviated words while FGDC uses all lowercase with abbreviated words.

Others have also compared the FGDC and ISO standards. Ying [23] compared the primary metadata sections of the two standards and noted that the ISO standard was more complete in four areas. In the area of maintenance information, the ISO standard allowed for the detailed definition of updates to the dataset. The FGDC standard does not approach the detail of the ISO standard in this description. Regarding data constraint information, ISO allows for managing the rights to information including restrictions related to patents, copyrights, trademarks and intellectual property rights. Both standards allow for security classification. Information pertaining to the cataloguing rules used for the data (in ISO terminology, the portrayal catalogue) was also stronger in ISO, where detailed information on alternate titles, edition numbers, and responsible party information provides citation details. Finally, application schema information was noted as more complete in ISO. Application schema refers to the schema used by the software system that built the dataset. The schema may be provided with the dataset in various forms (e.g., as an ASCII file, graphics file, software development file, etc.).

7. Concluding Remarks

Metadata will play a role of growing importance in the management of network-available data and information. Although the network functionality providing this information could be described as push or pull, the metadata will act as the summary and possibly the basis of the push/pull decision for delivery of the data and information.

The report specifically considers geospatial metadata by examining major international efforts in the field. Only the ISO and FGDC standards appear to meet the needs of the research community dealing with geospatial metadata. For the user creating the necessary elements within the standard, the FGDC documentation is much easier to understand and is more compact. The ISO standard, by referencing other equally complicated standards, is difficult to follow. The all-lowercase short names in the FGDC standard also provide programmers with easy rules for naming conventions.

Based on this investigation, the FGDC Content Standard for Digital Geospatial Metadata appears to be sufficient in scope for a wide variety of datasets and data sharing requirements. This standard would be applicable to data sharing requirements of datasets related to such topics as ocean mapping and feature identification.

8. References

1. Ewalt, David M. The Next Web, InformationWeek, Oct 14, 2002.

2. GOL. 2001. GOL Project Office, http://www.tc.gc.ca/gol/menu.htm

3. Speech from the Throne. 2001. http://www.pco-bcp.gc.ca/default.asp?Language=E&Page=InformationResources&sub=sftddt

4. GOL, 2001a. Selecting and Implementing a Metadata Standard for the Government of Canada, Government On-Line Ad Hoc Interdepartmental Metadata Working Group, unpublished manuscript, March 22, 2001.

5. WMO. 2001. Meeting of the Expert Team on Integrated Data Management, Final Report, Geneva, 5-8 November 2001, http://www.wmo.ch/web/www/WDM/reports/ET-IDM-2001.pdf

6. Gorman, Mal, James Kelly, Chris Ryan, Charles Sanders. 2002. Meteorological Data and XML, unpublished manuscript.

7. Scientific Excellence for Canada's Defence, Annual Report 2000-2001, Defence Research and Development Canada.

8. Rumizen, Melissie Clemmons. The Complete Idiot's Guide to Knowledge Management, CWL Publishing Enterprises, 2002.

9. Isenor, Anthony W., J. Robert Keeley and Joe Linguanti. 2003. Developing an eXtensible Markup Language (XML) Application for DFO Marine Data Exchange via the Web, Final Report to Fisheries and Oceans Science Strategic Funds, in preparation.

10. Haas, Stephanie. Research Metadata on the Web: Selected Geospatial Data and Metadata Directories, Marston Science Library, University of Florida, Gainesville, FL 32611-7011, http://web.uflib.ufl.edu/msl/metadata/metadata.pdf.

11. Dublin Core Metadata Initiative, www.dublincore.org

12. NISO. (2001). The Dublin Core Metadata Element Set, ANSI/NISO Z39.85-2001, ISSN: 1041-5653, An American National Standard Developed by the National Information Standards Organization.

13. ISO. 1998. Codes for the representation of names of countries and their subdivisions - Part 2: Country subdivision code, ISO 3166-2.

14. ISO. 1997. Information and documentation - Bibliographic references - Part 2: Electronic documents or parts thereof, ISO 690-2.

15. ISO. 2000. Geographic information – Metadata, ISO 19115-3.

16. Information Retrieval (Z39.50): Application Service Definition and Protocol Specification, National Information Standards Organization (U.S.), ISSN: 1041-5653 National Information Standards series, ISBN: 1-880124-22-X, 1995.

17. GCMD Marine Environmental Data Information referral catalogue, see http://gcmd.gsfc.nasa.gov/.

18. FGDC, 2000. Federal Geographic Data Committee. Content Standard for Digital Geospatial Metadata Workbook Version 2.0, Federal Geographic Data Committee. Washington, D.C.

19. FGDC, 1998. Federal Geographic Data Committee. FGDC-STD-001-1998. Content Standard for Digital Geospatial Metadata (revised June 1998). Federal Geographic Data Committee. Washington, D.C.

20. IOOS. 2002. Metadata/Data Discovery Team.

21. CDP, 2002. General Guidelines For Descriptive Metadata Creation & Entry, http://coloradodigital.coalliance.org/glines.html (9 October 2002).

22. Canadian GILS Guidelines, Guidelines for the Preparation of Governmental Information Locator Service records, Dec. 30, 1998.

23. Teng, Ying. 2000. Use of XML for Web-Based Query Processing of Geospatial Data, Thesis TR00_135, Master of Computer Science, University of New Brunswick.

List of symbols/abbreviations/acronyms/initialisms

ANSI	American National Standards Institute
CBS	Commission for Basic Systems
CDP	Colorado Digitization Project
COE	Common Operating Environment
CSDGM	Content Standard for Digital Geospatial Metadata
DND	Department of National Defence
DRDC Atlantic	Defence R&D Canada – Atlantic
DIF	Directory Interchange Format
DISA	Defense Information Systems Agency
EOSDIS	Earth Observing System Data and Information System
FGDC	Federal Geographic Data Committee
GCMD	Global Change Master Directory
GILS	Global Information Locator Service
GOOS	Global Ocean Observing System
GOL	Government On-Line
GTS	Global Telecommunications System
IKM	Information, Knowledge Management
IOOS	Integrated Ocean Observing System
ISO	International Organization for Standardization
MEDI	Marine Environmental Data Information referral catalogue

METOC	Meteorology and Oceanography Centre
NASA	National Aeronautics and Space Administration
NISO	National Information Standards Organisation
NLC	National Library of Canada
SHADE	Shared Data Engineering group
STB	Sonar Test Bed
TC	Technical Committees
UML	Unified Modelling Language
WMO	World Meteorological Organization
XBT	eXpendable BathyThermograph

Distribution list

LIST PART 1:

2 DRDC ATLANTIC LIBRARY FILE COPIES
3 DRDC ATLANTIC LIBRARY (SPARES)
1 AUTHOR
1 R. T. KESSEL
1 W. A. ROGER
1 M. E. LEFRANÇOIS
1 G. R. MELLEMA
1 B. A. MCARTHUR
1 LCDR. M. B. MACLENNAN
1 J. S. KENNEDY

13 TOTAL LIST PART 1

LIST PART 2: DISTRIBUTED BY DRDIM 3

1 NDHQ/ ADMS&T/ DRDKIM 3

1 É. Bossé
H/Decision Support Systems Section
Defence R&D Canada - Valcartier
2459 Pie-XI Blvd. North
Val-Belair, Quebec
Canada, G3J 1X5

1 Pierre Clement
Marine Environmental Sciences Division
Bedford Institute of Oceanography
PO Box 1006
Dartmouth, N.S.
B2Y 4A2

1 Donald W. Collins
U.S. National Oceanographic Data Center
1315 East West Highway, 4th Floor,
Silver Spring MD, 20910,
USA

1 Doug Gregory
Ocean Sciences Division
Bedford Institute of Oceanography
PO Box 1006
Dartmouth, N.S.
B2Y 4A2

1 J. Robert Keeley
Marine Environmental Data Service
Department of Fisheries and Oceans
W12082 - 200 Kent Street
Ottawa, Ontario Canada
K1A 0E6

1 Joe Linguanti
Institute of Ocean Sciences
PO Box 6000, 9860 West Saanich Road
Sidney, B.C.
V8L 4B2

1 Dr. Roy Lowry
British Oceanographic Data Center,
Proudman Oceanographic Laboratory,
Bidston Observatory, Prenton,
Merseyside, CH43 7RA,
United Kingdom

1 Tobias Spears
Informatics
Bedford Institute of Oceanography
PO Box 1006
Dartmouth, N.S.
B2Y 4A2

1 Y. Van Chestien
H/Information and Knowledge Management Section
Defence R&D Canada - Valcartier
2459 Pie-XI Blvd. North
Val-Belair, Quebec
Canada, G3J 1X5

10 TOTAL LIST PART 2

23 TOTAL COPIES REQUIRED

DOCUMENT CONTROL DATA

(Security classification of title, body of abstract and indexing annotation must be entered when the overall document is classified)

1. ORIGINATOR (the name and address of the organization preparing the document.. Organizations for whom the document was prepared, e.g. Centre sponsoring a contractor's report, or tasking agency, are entered in section 8.) Defence R&D Canada – Atlantic PO Box 1012 Dartmouth, Nova Scotia B2Y 3Z7	2. SECURITY CLASSIFICATION (overall security classification of the document including special warning terms if applicable). UNCLASSIFIED

3. TITLE (the complete document title as indicated on the title page. Its classification should be indicated by the appropriate abbreviation (S,C,R or U) in parentheses after the title).

The Importance of Metadata in System Development and IKM

4. AUTHORS (Last name, first name, middle initial. If military, show rank, e.g. Doe, Maj. John E.)

Anthony W. Isenor

5. DATE OF PUBLICATION (month and year of publication of document) February 2003	6a. NO .OF PAGES (total containing information Include Annexes, Appendices, etc). 28	6b. NO. OF REFS (total cited in document) 23

7. DESCRIPTIVE NOTES (the category of the document, e.g. technical report, technical note or memorandum. If appropriate, enter the type of report, e.g. interim, progress, summary, annual or final. Give the inclusive dates when a specific reporting period is covered).

TECHNICAL MEMORANDUM

8. SPONSORING ACTIVITY (the name of the department project office or laboratory sponsoring the research and development. Include address).

Defence R&D Canada – Atlantic
PO Box 1012
Dartmouth, NS, Canada B2Y 3Z7

9a. PROJECT OR GRANT NO. (if appropriate, the applicable research and development project or grant number under which the document was written. Please specify whether project or grant). 11ct01	9b. CONTRACT NO. (if appropriate, the applicable number under which the document was written).
10a ORIGINATOR'S DOCUMENT NUMBER (the official document number by which the document is identified by the originating activity. This number must be unique to this document.) DRDC Atlantic TM 2003 - 011	10b OTHER DOCUMENT NOs. (Any other numbers which may be assigned this document either by the originator or by the sponsor.)

11. DOCUMENT AVAILABILITY (any limitations on further dissemination of the document, other than those imposed by security classification)

(x) Unlimited distribution
(   ) Defence departments and defence contractors; further distribution only as approved
(   ) Defence departments and Canadian defence contractors; further distribution only as approved
(   ) Government departments and agencies; further distribution only as approved
(   ) Defence departments; further distribution only as approved
(   ) Other (please specify):

12. DOCUMENT ANNOUNCEMENT (any limitation to the bibliographic announcement of this document. This will normally correspond to the Document Availability (11). However, where further distribution (beyond the audience specified in (11) is possible, a wider announcement audience may be selected).

13. ABSTRACT (a brief and factual summary of the document. It may also appear elsewhere in the body of the document itself. It is highly desirable that the abstract of classified documents be unclassified. Each paragraph of the abstract shall begin with an indication of the security classification of the information in the paragraph (unless the document itself is unclassified) represented as (S), (C), (R), or (U). It is not necessary to include here abstracts in both official languages unless the text is bilingual).

Metadata is important when considering online data and information management. Metadata allows the data and information to be summarized within the context and language of the content theme. As such, it is important for searches and providing relevant information to the client. A comparison of metadata standards was conducted with emphasis on the standards capacity for geospatial metadata. Five standards were considered in detail: Dublin Core, GILS, GCMD, FGDC and ISO 19115. Each standard was considered from the standpoint of the required minimum information set and the geospatial information set. The usefulness of the various standards to geospatial data and information is considered within the context of ocean environmental data. Results indicate the FGDC standard is a complete and succinct metadata standard, with sufficient scope to be applicable to a wide variety of datasets.

14. KEYWORDS, DESCRIPTORS or IDENTIFIERS (technically meaningful terms or short phrases that characterize a document and could be helpful in cataloguing the document. They should be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location may also be included. If possible keywords should be selected from a published thesaurus. e.g. Thesaurus of Engineering and Scientific Terms (TEST) and that thesaurus-identified. If it not possible to select indexing terms which are Unclassified, the classification of each should be indicated as with the title).

XML
Metadata
Information Knowledge Management
IKM
Geospatial

Defence R&D Canada

Canada's leader in defence
and national security R&D

R & D pour la défense Canada

Chef de file au Canada en R & D
pour la défense et la sécurité nationale

DEFENCE DÉFENSE

www.drdc-rddc.gc.ca